

ADDITIONAL TAXONOMIC STUDIES OF *ARCEUTHOBIMUM PENDENS*
(VISCACEAE): A RARE DWARF MISTLETOE FROM CENTRAL MEXICO

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ABSTRACT

Additional measurements of male and female plants and staminate flowers are reported for *Arceuthobium pendens*. Measurements for fruits and seeds of this rare mistletoe are reported for the first time. Additional information on phenology and host reactions to infection is reported also.

RESUMEN

Se reportan mediciones adicionales de plantas masculinas y femeninas y de flores masculinas de *Arceuthobium pendens*. Las mediciones de frutos y semillas de esta rara especie de muérdago enano son reportadas por primera vez. Información adicional sobre floración y dispersión de semillas y reacciones del hospedero a la infección son también reportadas.

Key Words: pendent dwarf mistletoe, *Arceuthobium pendens*, *Pinus cembroides* subsp. *orizabensis*, *Pinus discolor*.

Arceuthobium pendens Hawsworth & Wiens (Viscaceae) was described in 1980 from the Sierra San Miguelito in southwestern San Luis Potosi, Mexico (Hawsworth and Wiens 1980). This dwarf mistletoe has only been discovered in two additional populations much farther south in Mexico and in close proximity to each other: northwest of Perote near Frijol Colorado in western Vera Cruz and on Cerro Pizarro in northeastern Puebla (Chazaro and Olivia 1987; Hawsworth and Wiens 1996; Hawsworth et al. 2002). Because this dwarf mistletoe is only known from three populations, it is currently considered to be one of the rarest dwarf mistletoes in Mexico (Hawsworth and Wiens 1996).

For this species, information on several morphological, phenological, and other attributes are limited or unavailable. When Hawsworth and Wiens (1980) described *Arceuthobium pendens*, they provided morphological data on the size and color of male and female plants and the size of staminate flowers. Because Hawsworth and Wiens' original specimens collected in 1979 from San Luis Potosi, as well as specimens collected by D. K. Bailey and T. Wendt in 1980 from Vera Cruz, were collected in early March, Hawsworth and Wiens did not have specimens of male plants with open flowers or female plants with mature fruits and seeds (Hawsworth and Wiens 1980). However, they were able to obtain measurements of staminate flowers from specimens collected by M. F. Robert in September 1971 that had male plants with mature staminate flowers. Hence,

they concluded that *A. pendens* probably flowered in September, but acknowledged that this was only an estimate based on the Robert specimens. Information on the period of seed dispersal for *A. pendens* reported by Hawsworth and Wiens (1996) was based on a report by Chazaro and Olivia (1987) who first reported the occurrence of *A. pendens* in Puebla (Cerro Pizarro) and indicated that it dispersed seed from June to September.

Because of the small amount of data provided by Hawsworth and Wiens (1980, 1996) we collected many additional specimens of *A. pendens* from near Frijol Colorado in Vera Cruz in late July 2005. This allowed us to complete many additional measurements of male and female plants. Since many male plants had begun flowering and several female plants had started seed dispersal, we were also able to measure male flowers and collect the first data on the size of mature fruits and seeds as well as estimate the periods of peak seed dispersal and flowering for *A. pendens* in Vera Cruz. These additional and new morphological measurements allowed us to make further comparisons between *A. pendens* and *A. divaricatum* Engelm., the only other dwarf mistletoe that parasitizes pinyons as principal hosts.

A total of 60 infected branches with plants of *A. pendens* (30 males and 30 females) were collected from 30 severely infected *Pinus orizabensis* trees approximately 8 km north of Frijol Colorado along the road to Los Humeros in western Vera Cruz, Mexico (19°37'N, 97°23'W, elev. 2740 m).

One male and one female infection with mature plants were collected from the lower part of the crown of each tree. Infections were collected haphazardly in that the first observed and easily accessed male and female infection with mature plants was sampled. The approximate location of this population is illustrated in Fig. 16.85 of Hawksworth and Wiens (1996). The plants were placed in paper bags, and all measurements were made within 24 hr of collection. The dwarf mistletoe plant characters measured were primarily those used by Hawksworth and Wiens (1996) in their monograph of *Arceuthobium*. The following morphological characters were recorded: 1) height and color of the tallest male and female plant from each infection collected; 2) mature fruit length, width, and color; 3) seed length, width, and color; 4) staminate flower diameter; 5) number, length, and width of staminate perianth lobes; 6) anther distance from the perianth lobe tip; 7) anther diameter; and 8) pre-flowering lateral staminate spike length and width. Dwarf mistletoe plants were measured using a Plasti-cal digital caliper accurate to 0.1 cm and all other measurements were made with a Bausch and Lomb 7 \times hand lens equipped with a micrometer accurate to 0.1 mm.

Specimens of male and female plants of *A. pendens* collected from the Vera Cruz population have been deposited at the Deaver Herbarium (ASC), Northern Arizona University, Flagstaff, AZ.

The heights of male and female plants (Table 1) were much greater than those reported by Hawksworth and Wiens (1980, 1996) for plants of *A. pendens* collected in the Sierra San Miguelito of San Luis Potosi. Hawksworth and Wiens (1980, 1996) reported that the maximum plant size for male plants of *A. pendens* was 22 cm, but we measured male plants 32 cm in height and many male plants (30%) were greater than 25 cm in height. Furthermore, while Hawksworth and Wiens (1996) commented that few female plants of *A. pendens* were larger than 8 cm, we commonly found female plants (50%) greater than 15 cm in height and the tallest female plant we measured was 26 cm. While male and female plants were both predominantly light green, the base of several older plants was dark green, and for some of the largest male and female plants, the base was dark brown, indicating that as the plants age their bases gradually change color.

Although Hawksworth and Wiens (1980) did not report how many plants of each sex they measured, they did comment that they only found two infected pinyons at the Sierra San Miguelito type locality in San Luis Potosi. Therefore, they may not have been able to measure many plants from that location. Because many trees were infected at the Vera Cruz location, we were able to measure a fairly large sample of male and female plants. Therefore,

our measurements are probably more representative of the mean sizes and ranges for male and female plants of *A. pendens*. Additional morphological measurements should be completed from the third population from Cerro Pizarro in Puebla to see how they compare to the Vera Cruz and San Luis Potosi populations.

The mean diameter of male flowers we obtained (2.6 mm) (Table 1) is approximately the same as that reported by Hawksworth and Wiens (2.5 mm). Most male flowers were 3-merous, but rarely 4-merous staminate flowers were observed on the terminal ends of staminate spikes.

Our measurements for perianth lobes, anthers, and staminate spikes, mature fruits and seeds (Table 1) are the first reported for *A. pendens*.

Most fruits were the same color as female plants, but some female plants had fruits that were dark green while the plants were light green. Seeds were light green and lacked the characteristic yellow cap that many species of *Arceuthobium* have on their mature seeds (Hawksworth and Wiens 1996).

Because several male plants had started flowering and several others had most of their flowers open in late July, it appears that the flowering period for *A. pendens* is probably from early July–September. Based on these observations, the peak flowering period is probably in August in Puebla and Vera Cruz and not in September as estimated for the San Luis Potosi population by Hawksworth and Wiens (1980).

Seed dispersal had already started for several female plants in late July and some female plants had nearly completed seed dispersal. Therefore, the seed dispersal period reported by Chazaro and Olivia (1987) of June–September is a good approximation. However, because many female plants had immature fruits in late July in the Vera Cruz population, the seed dispersal period may extend into early October for this population.

Typically, infections by *A. pendens* were non-systemic and did not induce witches' brooms, but when brooms were formed on trees in Vera Cruz, they were always associated with systemic infections as reported by Hawksworth and Wiens (1980, 1996) for the San Luis Potosi population. We observed that the systemic witches' brooms formed on some infected trees were induced by both male and female plants, but most of these brooms were associated with male plants as reported by Hawksworth and Wiens (1980, 1996); we only observed three systemic witches' brooms induced by female plants versus over 50 induced by male plants. In a few cases, systemic witches' brooms induced by male plants had one or even two female plants infecting one of the systemically male-infected branches within the broom. We did not see any female-induced systemic witches' brooms with male plants, but this condition probably occurs as well.

TABLE 1. MORPHOLOGICAL CHARACTERS MEASURED FOR 30 MALE AND 30 FEMALE PLANTS (PLANT HEIGHTS) AND FOR 50 STAMINATE FLOWERS, FRUITS, AND SEEDS OF *ARCEUTHOBIUM PENDENS* FROM VERA CRUZ, MEXICO.

Character	Mean	Standard Deviation	Range
Mean Plant Height (cm)			
Male	23	4.9	16–32
Female	16	4.2	7–26
Staminate Flower Diameter (mm)	2.6	0.1	2.3–2.9
Perianth Lobe Length (mm)	1.2	0.1	1.0–1.3
Perianth Lobe Width (mm)	1.1	0.1	0.9–1.2
Anther Diameter (mm)	0.6	0.1	0.5–0.8
Distance of Anther From Tip of Perianth Lobe (mm)	0.4	0.1	0.2–0.6
Staminate Spike Length (mm)	8	2.5	3–13
Staminate Spike Width (mm)	0.9	0.1	0.8–1.1
Fruit Length (mm)	3.4	0.4	2.6–4.1
Fruit Width (mm)	1.8	0.2	1.4–2.2
Seed Length (mm)	2.3	0.2	1.9–2.7
Seed Width (mm)	0.9	0.1	0.7–1.1

The mean diameter of staminate flowers and the mean length and width of fruits and seeds for *A. pendens* are approximately the same as those reported for *A. divaricatum*, the other dwarf mistletoe that parasitizes pinyons as principal hosts (Hawksworth and Wiens 1996). Although the size of male flowers, fruits, and seeds are similar for these two dwarf mistletoes, the morphology of the male and female plants is different for these taxa. Male and female plants of *A. pendens* are much larger (means 23 and 16 cm, respectively; maximum plant height 32 cm), than *A. divaricatum* (mean for all plants 8 cm; maximum height 13 cm) (Hawksworth and Wiens 1996). In addition, the light green color of male and female plants of *A. pendens* is in marked contrast to the dark greenish-brown plants of *A. divaricatum*. The male plants of *A. pendens* are commonly pendent as reported by Hawksworth and Wiens (1980), which is a clear contrast to the habit of male plants of *A. divaricatum* (Hawksworth and Wiens 1996). Furthermore, the flavonoid chemistry of *A. pendens* and *A. divaricatum* is quite different (Hawksworth and Wiens 1980) and the molecular evidence strongly supports the segregation of these dwarf mistletoes as separate species (Nickrent et al. 2004).

Although Hawksworth and Wiens (1980) initially classified the host of *A. pendens* in Vera Cruz as *P. cembroides* Zuccarini, they later

classified this pinyon population as *P. orizabensis* (Hawksworth and Wiens 1996; Hawksworth et al. 2002) based on a taxonomic treatment of this pinyon population proposed by Bailey and Hawksworth (1992). In San Luis Potosi, *A. pendens* was not observed parasitizing *Pinus cembroides*, although trees of this species were observed in the vicinity of the infected *Pinus discolor* D. K. Bailey & Hawksworth observed there (Hawksworth and Wiens 1980). While Hawksworth and Wiens (1996) and Hawksworth et al. (2002) have classified the host of *Arceuthobium pendens* at the Vera Cruz and Puebla locations as *Pinus orizabensis*, monographs of *Pinus* for Mexico and Central America by Perry (1991) and Farjon and Styles (1997) classify these pinyon populations as *P. cembroides* subsp. *orizabensis* D. K. Bailey. Whether or not *A. pendens* infects *P. cembroides* further north in Mexico needs to be determined and further research on the host range of *A. pendens* is definitely needed in central Mexico. However, finding additional populations of this cryptic and probably very rare dwarf mistletoe may prove difficult as suggested by Hawksworth and Wiens (1980).

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